PATTERNS OF FISH DIVERSITY IN THE RUPUNUNI SAVANNAHS, GUIANA SHIELD

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Abstract

The Rupununi Savannahs in south-western Guyana, (South America) contain an extremely rich and complex fish fauna. The area represents a possible connection point for fishes of the Amazon and Guiana Shield drainage systems, enabled by seasonal flooding between rivers at the upper-course of these two systems. Fish were surveyed from five sites in the Rupununi Savannahs during April 2004. Data from two previous studies in the area (1964 and 2002), were used to examine possible changes in the fish fauna through space and time. The differences found between these studies indicate that the fish species composition has changed during the last 45 years. These changes include the overall increased diversity of the area, and a decrease in the number of fishes shared between drainages. The effects this may have on the rest of the Guiana Shield are considered; but at this time appear to have little influence outside of the Essequibo drainage. The fish composition of the Guiana Shield appears to be mainly characterised by the morphological history of South-American rivers. Seasonal changes within the Rupununi Savannahs are also observed and thought to be primarily due to fish migration patterns.

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Introduction

"But it is probable that fresh-water fish are also enabled to migrate by changes of level causing streams to alter their course and carry their waters into adjacent basins. On plateaux the sources of distinct river systems often approach each other, and the same thing occurs with lateral tributaries on the lowlands…"

(Alfred Russel Wallace 1876)

Biogeographers since Alfred Russel Wallace (1876) found that the distribution of many terrestrial plant and animal species is often defined by major watercourses (Fernandes et al 2004). Similarly, river systems also influence the distribution of aquatic animals, such as freshwater fishes (Fernandes et al 2004, Lundberg et al 1998).

Gery (1969) identified eight faunal regions within South-America. For the purpose of this study, two are of special significance: the *Guianan-Amazonian* and the *Orinoco-Venezuelan* (*inset of Fig. 1*). Despite being grouped based on their species composition, the Guianan and Amazonian drainage basins are geologically distinct, defined and dissected by the mountain chains of the Guiana Highlands. Rivers south of the Highlands flow into the Amazon drainage, and those to the north flow into the Atlantic Ocean. Despite this, part of the Rio Negro catchment drains a portion of the south-western Guiana Shield and flows directly into the Amazon River. The Orinoco and Amazon drainages are however directly connected through the Casiquire Canal, a 200-mile long distributary of the Orinoco which alternates its direction of flow seasonally (Lowe-McConnell 1987). This leaves the Guiana Shield east of the Essequibo drainage, largely disconnected (*Fig. 1*).

The Rupununi Savannahs in south-western Guyana (2-4°N, 59-60°W) cover approximately 7500km^2 (Lowe 1964). In this area the Guiana Highlands give way to a vast flood-plain and a series of lakes, known collectively as Lake Amuku (*Fig. 2*). These savannahs experience seasonal flooding during the annual high water period when the rivers and creeks burst their banks from May till September. The area is dominated by three large rivers: the Rupununi, the Takatu, and its tributary, the Ireng. In this area the three rivers pass within approximately 30km of each other, separated by savannah, criss-crossed by a network of small rivers, creeks and lakes. The Rupununi River drains the central and eastern parts of the Savannahs, and flows east into the Essequibo. The Essequibo is the Guiana Shield's largest drainage and has many linkages with other rivers of the Guiana Shield. The Takatu and Ireng Rivers drain the western portion of the Rupununi Savannahs and flow west into what is eventually the Amazon via the Rio Branco and Rio Negro.

Lowe (1964) suggested that the presence of Amazon tributary headwaters, within the Rupununi Savannahs has evidently increased the number of fish species found there. Watkins et al (2005) highlighted that the Rupununi is situated between three major ichthyofaunal regions: the Orinoco, Guiana Shield, and the Amazon. Despite the presence of the Guiana Highlands, the Rupununi Savannahs represent a flattened area where tributaries from the Amazon and Essequibo drainages pass in close proximity. Rivers from both drainages at other parts of the Guiana Shield/Amazon boundary do pass close, yet only in mountainous areas where the scope for flooding is minimal. It can therefore be argued that the Rupununi Savannahs represent a link for fishes between the Amazon and Essequibo drainage systems, enabled by extensive flooding between the two (Gery 1969).
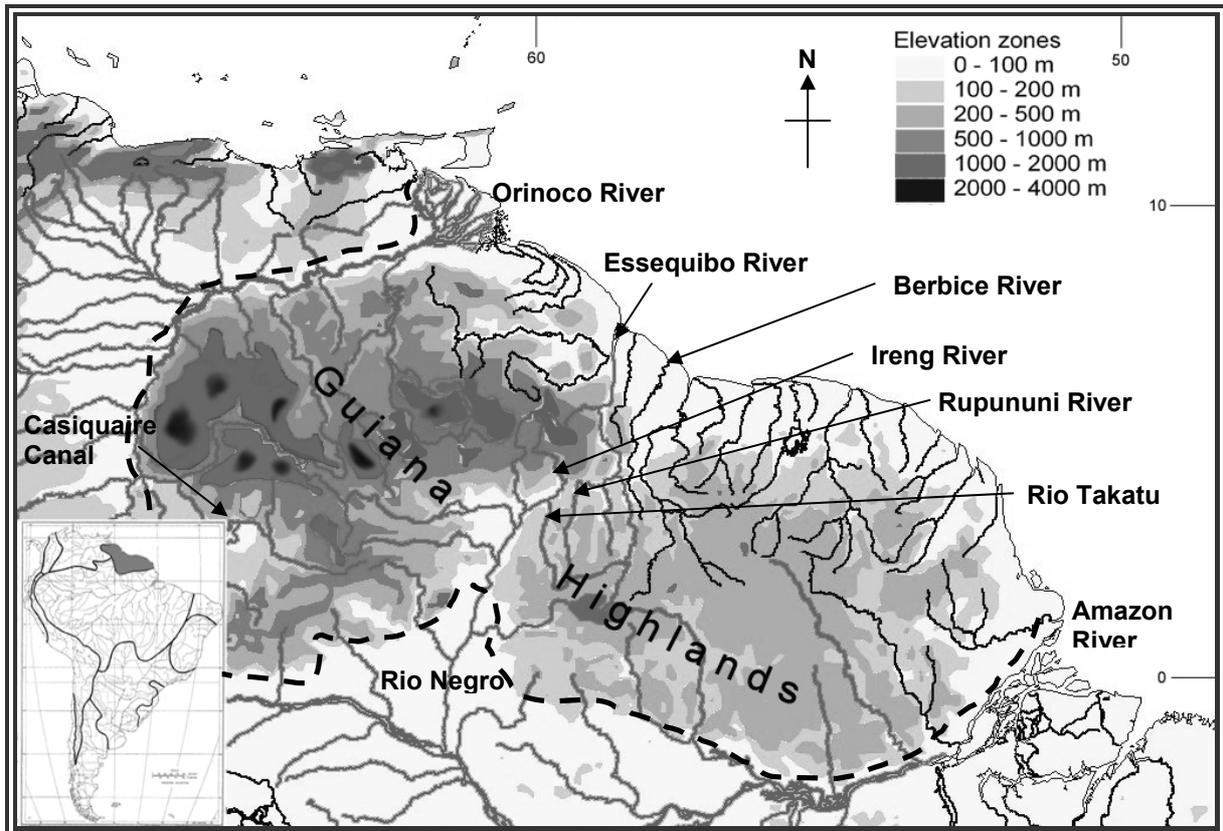
Fig. 1: *MAIN - Guiana Shield in north-eastern South-America; with water-courses referred to in the text. Dashed line depicts geologic Guiana Shield. INSET – Faunal zones of South-America. Shaded area: Guiana Shield (After Gery 1969).*

Methodology

Collection methods

Fishes were collected during the period, 8th to 14th April 2004. At this time of year, the rivers of the area are at their very lowest levels, with the beginning of the rains imminent. Five sites were surveyed, two from the Ireng/Amazon drainage, and three from the Rupununi/Essequibo drainage (*Fig. 2*).

As many micro-habitats as possible (site specific) were surveyed using multiple sampling methods, including, seines, drag nets, dip nets, hook and line, and cast nets. Two types of seines were used; firstly a cord mesh with 3cm^2 holes, 10m long; secondly a nylon mesh with 4cm^2 holes, 25m long. The fishing nylon mesh seine was used during day and night, but the cord mesh only at night due to its easy visibility. Seines were stretched across shallow parts of the rivers wherever possible. The drag net was a finely meshed cord, 5mm^2, heavily weighted along the bottom, and 5m long; used in shallow sloping areas, such as sand bars. Dip nets were used to sample nocturnal fish (i.e. Loricariidae), sleeping in submerged rocks and dead wood. Hook and line was used extensively to record larger species (i.e. *Cichla ocellaris*), and the Piranha species (*Serrasalmus, Pygocentrus, Pygopristis),* and in deeper parts of the river where seines proved ineffective. Cast nets were used in narrow creeks where seines were too large.

Data analysis

Sørensen (C_s) (1948) and Jaccard (1908) binary co-efficients of similarity were calculated to aid the comparisons of fish diversity. Both showed the same qualitative results therefore only the Sørensen is presented here. Similarity indices can quantify the level at which two data sets have aspects in common (Southwood & Henderson 2000), and have been used to analyse fish distributions (Ouboter & Mol 1993). In this context they were used to measure the extent to which the two drainages had species in common (space). They were also used to compare drainages between studies, to indicate whether changes in drainage species composition are occurring over time.
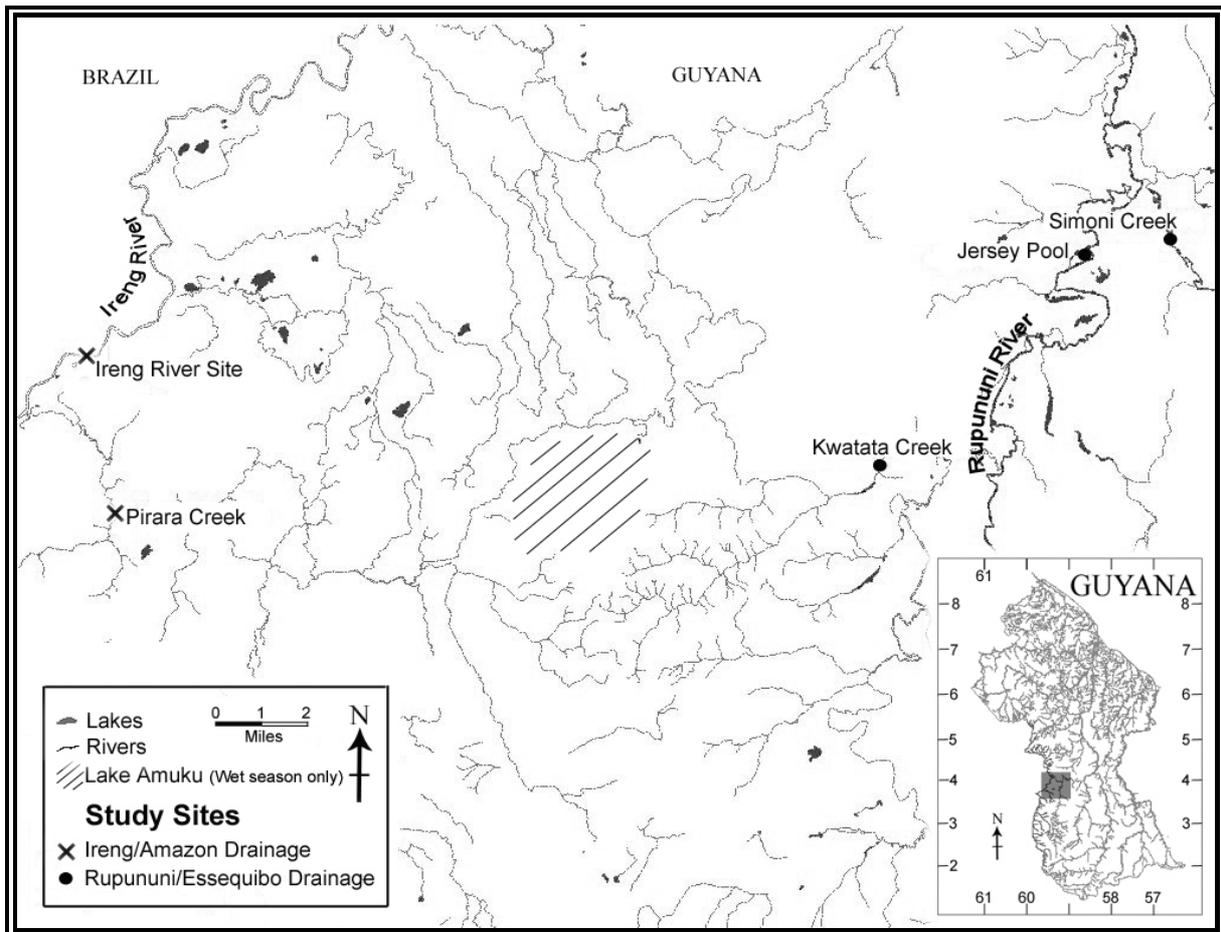
Fig. 2: *MAIN - Study sites from each drainage. Hashed area shows the lowland flooding where drainages become directly linked during the high water period. INSET - Study site in grey within the international boundaries of Guyana. Created Using: ArcView GIS (1992-1999).*

Results

Fifty-three species of fishes were recorded from sixteen families within six orders (Appendix 1). The majority were from just three orders - siluriformes (43%); characiformes (38%); and periciformes (9%). The other three orders only represented by one species each.

The similarity indices for the three studies showed that these two drainages have become more dissimilar over the past 45 years (Sørensen C_s=0.961 - 0.203). Data from this study showed that the two drainages were highly dissimilar at this time, with only 11% of species found in both drainages. Lowe (1964) found that 91%, occurred in both drainages; whereas Armbruster (2002) found only 50% of species occurred in

both drainages. The data for this study show many more species found in the Rupununi/Essequibo drainage, than in the Ireng/Amazon drainage. This was also true of the 2002 data, yet to not such a marked degree. The opposite was found in the 1964 study where slightly more species were found in the Ireng/Amazon drainage (*Table 1*).

Table 1: Summary statistics for the three studies. Total number of species found in each study; number species found per drainage; % of species common (shared) to both drainages; and Sørensen's (1948) coefficient of similarity between the two drainages. Data were also applied to the Jaccard (1908) similarity coefficient, which correlated closely with the Sørensen's.

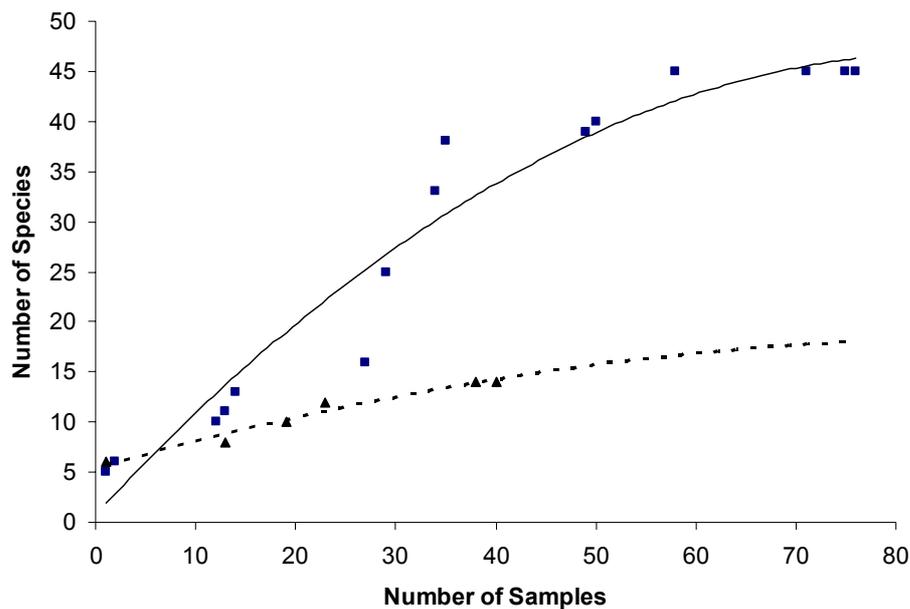|	Study		
	This Study (2004)	**Armbruster (2002)**	**Lowe (1964)**
Total no. species	53	282	133
Comparing drainages			
No. Species: Rupununi/Essequibo	45	222	124
Ireng/Amazon	14	207	132
% shared species	11	50	91
Drainage similarity (C_s)	0.203	0.655	0.961

When comparing between studies, the degrees of similarity are generally much lower than when comparing within studies (*Table 2*). Despite this, patterns can still be seen. It would appear that the Rupununi/Essequibo drainage has stayed consistently more similar than the Ireng/Takatu drainage over the last 45 years. The similarity indices suggest that the Lowe and Armbruster studies are the most similar throughout, which may be due to their larger sample size. However, it is also interesting to note that the least similar studies are this study compared with the Armbruster study, even though they took place only two years apart. Despite this, the actual number of species shared between the two, is high, relative to the amount of species found in this study. So 68% of the species found in this study were also found in the Armbruster study. This means that in this case, the Sørensen's is highly sensitive to sample size. Thus, if sample size is ignored, the Lowe (1964) study is noticeably dissimilar from both of the more recent studies.

Table 2: Number of shared species between studies. Sørensen's (1948) coefficient of similarity for comparisons between complete studies and drainages between studies. Data were also applied to the Jaccard (1908) similarity coefficient, which correlated closely with the Sørensen's.

Study comparison	No. shared species	Total similarity (C_s)	Drainage similarity (C_s)	
			Rupununi/Essequibo	**Ireng/Amazon**
This Study (2004) – Lowe (1964)	21	0.227	0.225	0.055
This Study (2004) – Armbruster (2002)	36	0.214	0.172	0.081
Lowe (1964) – Armbruster (2002)	52	0.249	0.255	0.224

It is important to note that this study was conducted during low water; whereas the Armbruster (2002) study was conducted during high water; and the Lowe (1964) study was carried out at several times throughout the seasonal cycle.

Despite the fact that less species were found in this study; the figure seems to be representative of the true number. When compared with the quantity of samples taken, the number of species found begins to level off within each drainage (*Fig. 3*). This indicates that the true number of species existing in the rivers at this time was little greater than the number of species found. This means that during the low water period, fish species diversity was lower, and there were relatively fewer species in the Ireng/Amazon drainage. The Armbruster data also found relatively fewer species in the Ireng/Amazon drainage, during high water. However, when both seasons are sampled (1964 study), the total number of species is greater in the Ireng/Amazon drainage. It is possible that these seasonal changes may be due to migration patterns.

Fig. 3: Data from this study. Number of species found corresponding to the number of samples. ■ = Rupununi/Essequibo Drainage (n=76), ▲ = Ireng/Amazon Drainage (n=40).

Discussion

It would seem that many processes affect the fish diversity patterns of the Rupununi Savannahs. These changes are not only between the two drainages, but also through time; over the last 45 years and seasonal. These changes may be due to many factors, including fish migrations, geological history and more importantly, the dispersal of fishes between the Amazon and Essequibo drainages. Preliminary data suggest that all of these play a role in explaining the fish species composition of this area.

It should be noted that an increasing human population in the area may reduce the numbers of particular food fishes. Also, increasing pressure from the mining of precious minerals and deforestation (Hamilton et al 2002) may influence the fish communities as a whole. These human pressures are more apparent on the Brazilian side (Ireng/Amazon) of the Rupununi Savannahs where development is accelerating faster than on the Guyana side. Despite this, the most accessible parts of the Guyana side, (where most sampling was done), are also the most populated parts. Yet these population numbers are not high with less than 8 people/km^2.

Data analysis

The data suggest that the rivers of the Rupununi Savannahs have changed quite significantly during the last 45 years. Overall species diversity seems to have increased, but more species are now being found in the Essequibo/Rupununi drainage, as opposed to the 1964 data which found more in the Ireng/Amazon. Also importantly, less species are now found in common between the two drainages. These are most reliably seen by contrasting the Lowe and Armbruster studies which are more extensive than this study (*Tables 1 & 2*). The increase in overall species diversity is surprising considering the Lowe (1964) study was carried-out over a number of years and seasons, whereas the Armbruster (2002) study was performed during one season of one year. These data thus provide strong evidence that fishes have dispersed between drainages at some point during the last 45 years. However, many aspects of fish diversity and dispersal patterns must be considered before suggesting that this has moulded the species composition of the Rupununi Savannahs.

Difference between drainages

A number of species were found consistently in both drainages, and at multiple sites. Most notably the Red-bellied Piranha (*Pygocentrus nattereri*), was found to be widely distributed. This is likely due its generalised, carnivorous nature (Goulding 1980). *P. nattereri* is found throughout South and Central-America east of the Andes; in all kinds of drainage types (Reis et al 2003). Additionally *Prochilodus spp.* are among the most abundant and widespread of all South-American fish, and like *P. nattereri* have enabled this by feeding upon abundant resources, in this case detritus (Sivasundar et al 2001). *Prochilodus* are well-known for their long-distance up-stream migrations, and were consistently found throughout the Rupununi Savannahs in both drainages.

Some fishes however appear to be restricted to one or other drainage. *Cichla temensis* is one such species found only from the Amazon drainage. It has never been observed in the Essequibo drainage; yet the closely related, *Cichla ocellaris* is found in both drainages. Three possible hypotheses can be applied to explain this. Firstly, fishes that have actually crossed between drainages must be able to withstand the conditions of the flooded savannah (Lowe 1964). Secondly, fishes found in both drainages must be able to withstand conditions within both. Thirdly, and most easily explained using *Cichla,* is competition. *C.ocellaris* and *C.temensis* are both predatory, exploiting similar resources as one another (Winemiller et al 1997). It may also be key to note that some species appear to be found in the Essequibo and Amazon drainages, but not elsewhere in the Guiana Shield east of the Essequibo. This is true of *Arapaima gigas*, and possibly many more.

Seasonal changes and migration

The data from this study can be compared with the Armbruster data to indicate seasonal changes in species diversity (sampled at different times of the seasonal cycle). During the low water period it is common for shallow headwaters to become scarce in fish populations. As pools dry-out, the remaining fishes become easy prey (Watkins et al 2005), and human fishing pressures become accentuated. Fish migration patterns are controlled by seasonally changing water levels and the availability of oxygen (Lowe 1964, Lowe-McConnell 1995, Watkins et al 2005). Many Rupununi fishes disperse and spawn based on these changes. With the marked rainy season experienced in the Rupununi, rivers flood the surrounding low-lying land from approximately May until September. These changes in water levels modify the available habitats in the area; as more land is flooded, more habitats and thus resources become available. These processes trigger the spawning of various Rupununi fish, many of which migrate up-river into adjacent creeks and tributaries, or onto the flooded savannah in which to spawn in safety (Lowe 1964, Lowe-McConnell 1977, Watkins et al 2005). Because there is a great advantage for fishes advancing onto the flooded savannah, it makes the probability of dispersing between drainages ever more likely.

Dispersal patterns in the Ireng/Amazon seem to be more complicated than in the Rupununi/Essequibo. It seems that different meteorological patterns cause different fish migrations, as fishes migrate upstream from the Rio Negro through May to July, and then again in October until December (Goulding et al 1988). This means that fish compositions in the whole of the Rupununi Savannahs as well as the individual drainages will change throughout the seasonal cycle.

Crossing the divide

Rivers in this area, experience an average, annual change in water level of six metres (Watkins et al 2005). Including the Brazilian components of the Rupununi savannahs, the typical area flooded each season is 3,095km^2, for a period of 49 days (Hamilton et al 2002). One assumption made by this study, is that fishes have the ability to cross these large expanses of shallow, inundated grassland. There are several factors to consider when determining whether a species may have this ability. Firstly, and maybe most importantly, the water chemistry of these two systems are markedly different. The Rupununi River is categorised as 'white water'; the Ireng on the other hand is known as 'black water'. Studies by Carter (1934) found that black waters have a low pH, low oxygen levels and high carbon dioxide levels. White waters however, are approximately pH neutral, generally abundant in oxygen and carbon dioxide and frequently more turbid than black waters. Carter (1934) also studied the grass swamp areas such as seasonally flooded savannah, finding that they were highly acidic due to exceedingly high carbon dioxide levels, and the oxygen content was the lowest of all water types. Possibly more significantly, black waters have been shown to be nutrient poor compared with white waters (Goulding et al 1988, Winemiller et al 1997).

These extreme differences in water chemistry have clear implications for the kinds of fish that can cross between drainages. Smaller fish or juveniles may have an advantage as their requirements may be lower (Wootton 1992). However, air-breathers like some of the cat-fishes (*Ancistrus, Callichthys*) and the osteoglossid (*Arapaima gigas*) may not be affected by the lack of oxygen within the waters of the flooded grassland. *A.gigas* is one of the world's largest freshwater fishes, growing to 12 feet long and weighing up to 300lbs (Gery 1969). At this size it is hard to imagine adults would be able to cross shallow, flooded savannah. However, it is an obligatory air breather (Galdames-Portus et al 1979, Powers et al 1979) and is known from both drainages (Lowe 1964). The pink river dolphin *Inia geoffrensis*; a mammal, thus lung breather, is known from the Amazon and Orinoco (Hamilton et al 2001), but not the Guiana Shield east of the Rupununi Savannahs (Meade & Koehnken 1991). *I.geoffrensis* is even found in the same areas of the Ireng sampled in this study (personal observation), yet not in the Rupununi River. The osteoglossids represent some of the world's oldest extant teleosts, part of the osteoglossomorpha, who were first seen in the fossil record during the Jurassic, approximately 150mya (Lavoué & Sullivan 2004). However, the river dolphins appeared much later during the early Oligocene, approximately 35mya. It is clear that dispersal abilities are not the only reason behind the distribution of the Guiana Shield's fishes. For this reason, the geological history of the rivers must be examined.

Geological History

The Guiana Shield represents some of the Earth's oldest rock, dating back to the early Proterozoic (Gibbs & Brown 1993). Lundberg (1998) found that most Neotropical fish diversification has taken place over the last 90my (Cretaceous), after the continent became disconnected from the larger landmass of Pangaea. Since this separation, the drainages have gone through major alterations, mostly caused by the upheaval of the Andes. This created the formation of new watershed divides, particularly the divergence of the Amazon during the Miocene (Lowe-McConnell 1975). It is also evident that the area now drained by the Takatu River (Amazon drainage) was once part of the headwaters of a river which flowed north-east into the Guiana Shield through the Berbice River (*Fig. 1*). However, it seems the flow of this river diverted south into the Amazon during the late tertiary (McConnell 1959). This may mean that the river systems of the Guiana Shield and Amazon became separated at this time; possibly before the appearance of *I.geoffrensis.* These major fluctuations in river morphology have lead to many species encompassing a much larger distribution than may initially be expected. Gery (1969) found that the Guiana Shield fish composition has many affinities with the Peruvian Amazon (2000km away), yet less so with the central Amazon. So fishes found both in the Guiana Shield and in the Amazon would not necessarily have to cross any extreme boundaries.

Patterns across the Guiana Shield

One major factor pointing to movements between the two drainages, especially in the Rupununi area, is that the fish species diversity appears to decrease moving east across the Guiana Shield, further from the Rupununi. (Approximate diversity; Venezuela = 1,000, Guyana = 700, Suriname = 450, French Guiana = 475 (Lasso et al 2002)). A preliminary count using all studies conducted in the Rupununi area suggests

that well over 600 species may be found here[2]. This agrees with Watkins et al (2005) who studied fishes in the Iwokrama Forest area (Essequibo River) approximately 100 miles north of the Rupununi Savannahs. Watkins et al (2005) applied their data to a species accumulation curve to estimate diversity, using EstimateS.5 (Colwell 1997). This yielded estimates of up to 747 species for the areas they sampled alone. Because of this, it seems that the 700 figure is not representative of the true number of fishes found in Guyana's freshwaters. Some areas, east of Guyana (Suriname and French Guiana) have been more extensively surveyed, and on first glance appear to be higher in endemics than Guyana (Lasso et al 2002). It is possible that numerous volcanic dykes forming rapids and waterfalls throughout the Essequibo act as major dispersal limiters (Hardman et al 2002).

Dispersal implications for biodiversity

It is clear that many factors have caused the high diversity found in the Rupununi. Firstly, a wide range of habitats supports a vast mosaic of niche availability. Rainforest, savannah, rivers, creeks, ponds and ox-bow lakes allow for this hugely diverse number of species to co-exist (Watkins et al 2005). However, this is true of many South-American drainages. Goulding et al (1988), in a fairly extensive study of the Rio Negro (Northern Brazil) found approximately 450 species of fishes, and estimated the true number to be around 700. Goulding et al (1988) suggested that this made it the most ichthyologically diverse tributary in the world. The Rio Negro covers an area of 750,000km^2, approximately three times the size of the entire Essequibo drainage, and one-hundred times the size of the Rupununi River drainage. With over 600 species already identified from the Rupununi, it is clear that many more factors than niche diversity are playing major roles in this elevated species richness. Thus, it seems ever more likely that the extraordinary species diversity of the Rupununi is due to location.

The area seems to contain a variety of species from two drainages that have been geographically separate for many millions of years. Over these years adaptive radiation has occurred through geographic isolation, causing the fish faunas of these drainages to become distinct through vicariance. Similarly, and on a more localised scale, assuming that at each high water period, there is a constant body of water between these two drainages there is always the possibility of fishes crossing between drainages. However, for some fishes movement between drainages may only be possible during infrequent periods of extreme high water. Because these types of heavy rains may only occur once in a century, speciation may again be enabled through geographical separation from the founder population. This process may actually increase the diversity of the Rupununi and the Guiana Shield alike. However, the relative lack of endemics in the Guiana Shield, especially the Rupununi, do not support this.

Conclusions

It seems that the impressive fish diversity of the Rupununi is due to a number of factors. Preliminary data suggest that one of these factors is the present day dispersal of fishes between the Guiana Shield and Amazon systems. It seems quite likely that this kind of dispersal over shallow, oxygen depleted savannah is limited to certain types of fishes however. It is evident that the Rupununi area is comprised of a mixture of fishes from both drainages, and importantly, contains many Amazon fishes which are not found elsewhere in the Guiana Shield east of the Essequibo drainage. Fish migrations may also play a major role in explaining changes in species composition throughout the seasonal cycle, and may act as a drive for dispersal between drainages. The data support the hypothesis of dispersal between drainages within the Rupununi. However, it seems that the fish species composition of the rest of the Guiana Shield (east of the Essequibo drainage) is due to geological history. Thus, dispersal between these two drainages provide a strong case in explaining the species composition at the local, Rupununi scale.

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[2] Includes this study, Lowe 1964, Armbruster 2002, and Watkins et al 2005.

Acknowledgments

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Appendix

Appendix 1: *Species found in this study. 0=absent from drainage; 1=present in drainage.*

ORDER, Family, *Genus & Species*	Rupununi/Essequibo	Ireng/Amazon
CHARACIFORMES		
Anostomidae		
Caenotropus maculosus	0	1
Characidae		
Acestrorhynchus microlepis	1	0
Aphyocharax erythrurus	1	0
Ctenobrycon spilurus	1	0
Hemigrammus cylindricus	1	0
Hydrolycus scomberoides	1	0
Hyphessobrycon catableptus	1	0
Iguanodectes spilurus	1	0
Moenkhausia sp.	1	0
Myleus sp.	1	0
Pygocentrus nattereri	1	1
Pygopristis denticulatus	1	0
Serrasalmus humeralis	1	0
Serrasalmus rhombeus	1	0
Tiportheus rotundatus	0	1
Curimatidae		
Curimata sp.	1	0
Hemiodontidae		
Hemiodopsis microlepis	1	1
Hemisorubim platyrhynchos	1	0
Prochilodontidae		
Prochilodus sp.	1	1
Prochilodus nigricans	1	0
OSTEOGLOSSIFORMES		
Osteoglossidae		
Osteoglossum bicirrhosum	1	0
PERCIFORMES		
Cichlidae		
Cichla ocellaris	1	0
Geophagus surinamensis	1	1
Mesonauta guyanae	0	1
Satanoperca leucosticta	0	1
Sciaenidae		
Pachypops sp.	1	0
PLEURONECTIFORMES		
Achiridae		
Hypoclinmus mentalis	1	0

ORDER, Family, *Genus & Species*	Rupununi/Essequibo	Ireng/Amazon
SILURIFORMES		
Auchenipteridae		
Ageneiosus brevilis	1	0
Ageneiosus inermis	1	0
Callichthyidae		
Callichthys callichthys	1	0
Doradidae		
Acanthodoras cataphractus	1	0
Amblydoras affinis	1	0
Hassar sp.	1	0
Leptodoras linnelli	0	1
Leptodoras hasemani	1	0
Platydoras costatus	1	0
Heptapteridae		
Pimelodella sp.	1	0
Loricariidae		
Ancistrus sp.	1	0
Hemiancistrus sp.	1	0
Hypostomus cochliodon	1	1
Loricariichthys microdon	1	0
Loricariichthys sp.	1	0
Peckoltia sabaji	1	0
Pseudacanthicus leopardus	1	0
Rineloricaria sp.	1	0
Spatuloricaria sp.	0	1
Pimelodidae		
Megalonema sp.	0	1
Phractocephalus hemiliopterus	1	0
Pimelodus blochii	1	1
Pimelodus ornatus	0	1
Pseudoplatystoma fasciatum	1	0
Trichomycteridae		
Typhlobelus sp.	1	0
TETRAODONTIFORMES		
Tetraodontidae		
Colomesus psittacus	1	0